

ADVISORY COMMITTEE ON ARTIFICIAL LIMBS
NATIONAL RESEARCH COUNCIL

USING BODY MEASUREMENTS TO DETERMINE
PROPER LENGTHS OF ARTIFICIAL ARMS

PAMPHLET SERIES: No. 2

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FOREWORD

This is the second pamphlet of a series written to meet the practical needs of the prosthetist. It is a condensation of a report of the same title issued by this laboratory in January, 1951.

The prosthetic standards set forth have been obtained by combining both practical prosthetic principles and research findings. They are intended only as a guide to the prosthetist who must remember that the finished prosthesis is still essentially a product of his individual ability.

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INTRODUCTION

For the purposes of this booklet, amputees have been generally classed as either unilateral or bilateral for the following considerations:

1. *Unilateral* — a size agreement between the normal and prosthetic limbs is prescribed. This includes the length shortening generally accepted as necessary to account for "size illusion."
2. *Bilateral* — a method of determining the proper prosthetic lengths from the amputee's height is described.

In addition, the booklet gives an easy method of determining the maximum length of forearm stump which will accomodate various terminal devices, separately or interchangeably, with proper length agreement.

Finally, a table is presented which lists prosthetic dimensions for a wide range of amputee heights.

BASIC ASSUMPTIONS

1. *Relationship of normal hand to hook:*

The standard hook¹ should extend approximately to the tip of the normal thumb. This is to allow for the fact that the hook appears longer, when worn, than it actually is.

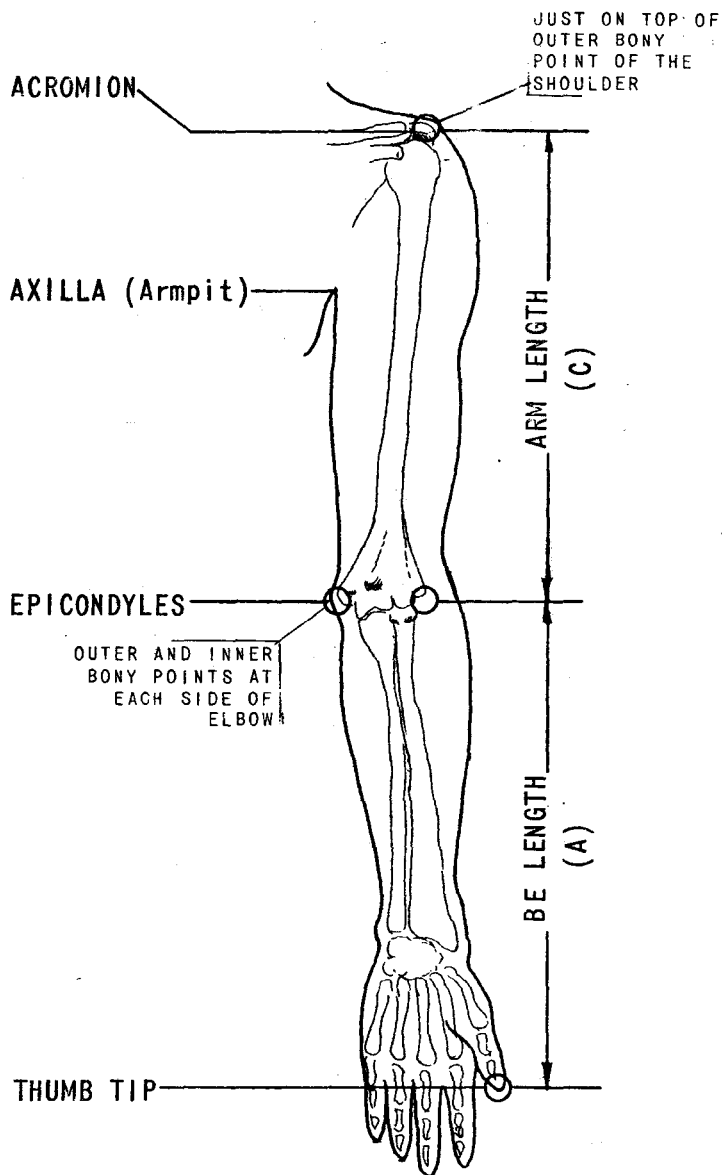
2. *Relationship of normal hand to prosthetic hand:*

The tip of the thumb of the APRL² hand should extend as far as the tip of the thumb of the normal hand. The APRL hand has been designed smaller than the average normal hand to allow for the "size illusion" factor as explained above.

¹ The Dorrance No. 5 hook, or equivalent, was selected as standard because of its widespread use.

² Army Prosthetics Research Laboratory.

LANDMARKS

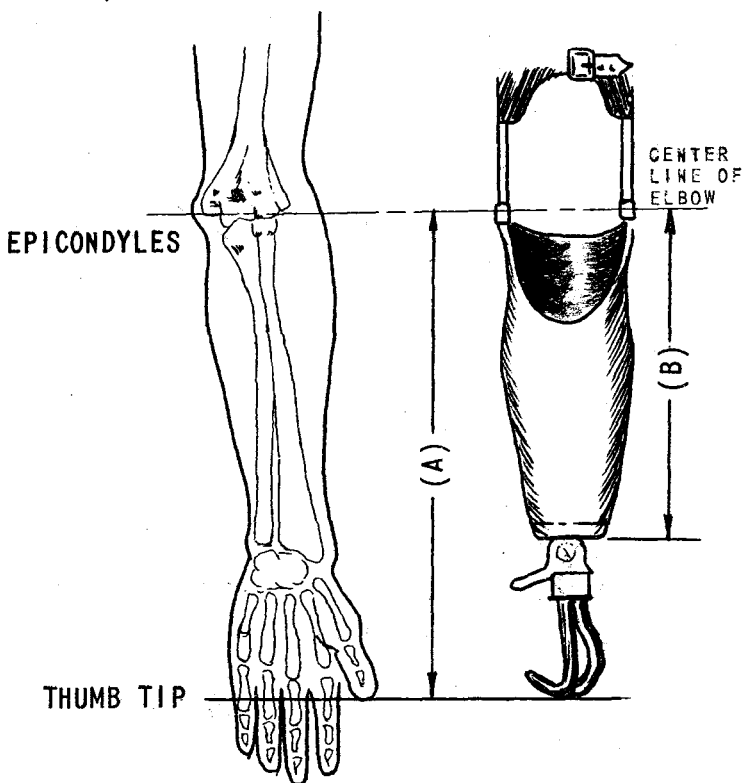


The landmarks which are encircled must be familiar to the prosthetist for successful utilization of this booklet.

A. SIZING THE UNILATERAL PROSTHESIS

1. Below-Elbow

Measure from the epicondyles to the thumb tip of the normal limb.

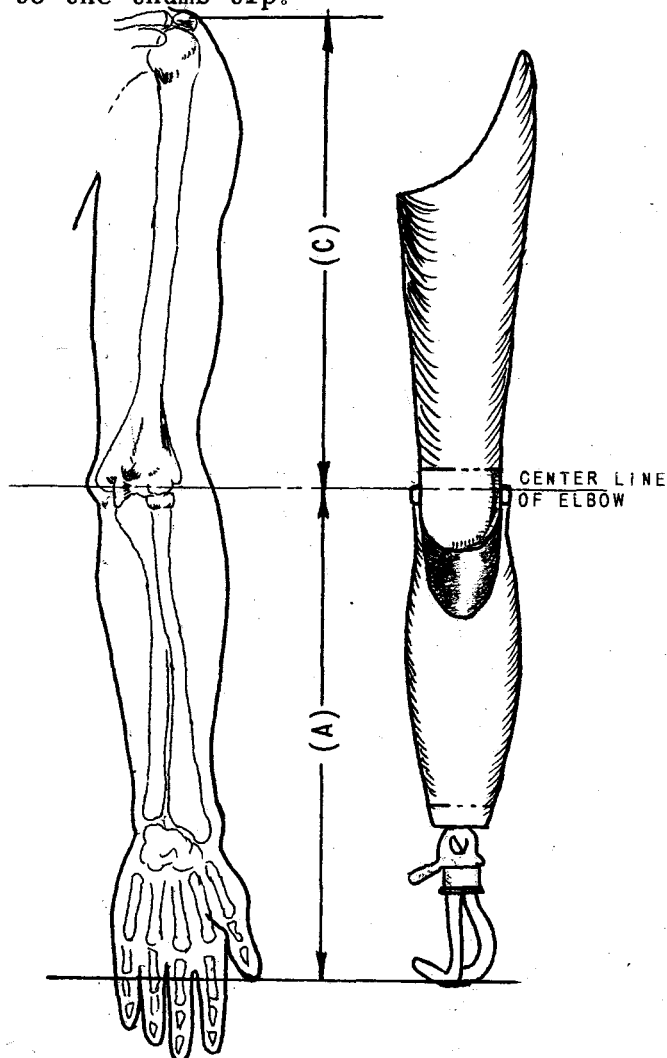


This length (A) is the distance from elbow pivot to hook end, as shown.

To determine the exact prosthetic forearm length (B), see page 10.

2. Above-Elbow

Measure from the acromion to the epicondyles and then from the epicondyles to the thumb tip.



The acromion to epicondyle length (C) is the distance from the acromion to the elbow pivot of the prosthesis.

The epicondyle to thumb tip length (A) is the distance from elbow pivot to hook end.

B. SIZING THE BILATERAL PROSTHESIS

1. Working Ratios

The following ratios were obtained from considering measurements of several hundred people.

a. Arm Ratio

$$\text{ARM RATIO} = 0.19$$

This means that the length of the arm (C) is about 0.19 times the height of any particular person.

b. Below-Elbow Ratio

$$\text{BE RATIO} = 0.21$$

This means that the below-elbow portion of a limb (A) is about 0.21 times the height of any particular person.

These ratios do not always hold true for very short or very tall persons. The prosthetist may have to apply his judgment in such cases.

2. How to Use the Ratios:

a. To determine the prosthetic ARM LENGTH and locate the elbow:

1. Measure the amputee's height in inches,
2. Multiply by 0.19,
3. The result is the proper arm length (C).

Example:

$$\begin{array}{rcl} \text{Amputee's height} & = & 70.0 \text{ inches} \\ \text{Arm ratio} & & \times 0.19 \\ \hline \text{Prosthetic Arm Length} & = & 13.30 \text{ inches} \end{array}$$

b. To determine the prosthetic BELOW-ELBOW LENGTH:

1. Measure the amputee's height in inches,
2. Multiply by 0.21,
3. The result is the proper below-elbow length (A).

Example:

$$\begin{array}{rcl} \text{Amputee's height} & = & 70.0 \text{ inches} \\ \text{BE ratio} & & \times 0.21 \\ \hline \text{Prosthetic BE length} & = & 14.70 \text{ inches} \end{array}$$

C. ALLOWABLE BELOW-ELBOW STUMP LENGTH

1. *Without Interchange of Terminal Devices*

a. Determine length (A) by measuring or by use of the BE ratio, if necessary, as per paragraph b, page 9;

b. Subtract the length of the terminal device;

The result is the exact length of the prosthetic forearm (B).

c. Subtract the length of the wrist unit, plus any special item such as a flexion unit, plus 0.25 inches for laminate thickness over end of stump and clearance;

The result is the allowable stump length for any particular hand or hook.

Example:

Suppose length (A) is	14.00 inches
Subtract standard hook	- 4.63 inches ³

Prosthetic Forearm Length = 9.37 inches

0.88 inches = Wrist unit length (may vary)
+0.25 inches = Clearance, etc.

1.13 inches = Total

Subtracting: 9.37 inches
-1.13 inches

8.24 inches

For the above example, a stump of about 8.25 inches and a forearm of 9.37 inches are indicated. Longer stumps, of course, must often be fitted. In such cases the end of the hook will extend beyond the point originally set as the maximum. See table on page 13 for listing of prosthetic arm and forearm lengths for a wide range of amputees.

³ For an APRL hook, use length = 6.25 inches.
For an APRL hand, use length = 5.13 inches.

2. *With Interchange of Terminal Devices*
(Standard hook, APRL hook or APRL hand)

a. Determine length (A) by measuring or by use of the BE ratio, if necessary, as per paragraph b, page 9;

b. Subtract length of terminal device;

The result is the exact length of the prosthetic forearm (B).

c. Subtract the length of the wrist unit, plus any special item such as a flexion unit, plus 0.25 inches for laminate thickness over end of stump and clearance;

The result is the allowable stump length for proper interchange of terminal devices.

Example:

$$\begin{array}{rcl} \text{Suppose length (A) is} & & 14.00 \text{ inches} \\ \text{Subtract base to thumb tip} & & \\ \text{of APRL hand plus adapter}^4 & - & 6.38 \text{ inches} \\ \hline \text{Prosthetic Forearm Length} & = & 7.62 \text{ inches} \\ 0.88 \text{ inches} = \text{Length of wrist unit (may vary)} & & \\ +0.25 \text{ inches} = \text{Clearance, etc.} & & \\ \hline 1.13 \text{ inches} = \text{Total} & & \\ \text{Subtracting: } 7.62 \text{ inches} & & \\ -1.13 \text{ inches} & & \\ \hline 6.49 & & \end{array}$$

This means that to wear either an APRL hook, an APRL hand with adapter or a standard hook with adapter or wrist flexion unit, the amputee's stump should be no longer than 6.50 inches from the epicondyles to the end. See table on page 12 for a listing of prosthetic arm and forearm lengths for a wide range of amputees.

⁴ An adapter is used to space the APRL hand away from the wrist unit to allow room for the operating cable. A fairing section covers the adapter. See report noted in Foreword.

D. TABLE OF PROSTHETIC LENGTHS

The table lists prosthetic arm and below-elbow dimensions for amputee heights of 60 to 78 inches. The exact length of the prosthetic forearm is listed as well as the nearest forearm size commercially available for use with the standard hook alone or for interchangeable use with the standard hook, APRL hook or APRL hand.

Knowing a unilateral amputee's arm or below-elbow length, the exact size of the prosthetic forearm (BE length minus terminal device and flexion unit or adapter) can be determined as well as the nearest commercially available size. Knowing only a bilateral's height, the prosthetic arm and forearm can be found.

AMPUTEE HEIGHT	PROSTHETIC BE LENGTH (A)	PROSTHETIC ARM LENGTH (C)
60	12.48	11.52
61	12.68	11.71
62	12.90	11.90
63	13.11	12.10
64	13.33	12.29
65	13.52	12.48
66	13.74	12.68
67	13.94	12.87
68	14.15	13.06
69	14.36	13.25
70	14.58	13.44
71	14.78	13.63
72	14.99	13.82
73	15.20	14.01
74	15.40	14.20
75	15.61	14.40
76	15.81	14.59
77	16.02	14.78
78	16.23	15.97

STANDARD HOOK ALONE		INTERCHANGEABLE	
EXACT FOREARM SIZE (B)	COMMERCIAL SIZE	EXACT FOREARM SIZE (B)	COMMERCIAL SIZE
7.85	7.5, 8	6.10	6
8.05	8	6.30	6, 6.5
8.27	8, 8.5	6.52	6.5
8.48	8.5	6.73	6.5, 7
8.70	8.5, 9	6.95	7
8.99	9	7.14	7, 7.5
9.11	9	7.36	7.5
9.31	9, 9.5	7.56	7.5
9.52	9.5	7.77	7.5, 8
9.73	9.5, 10	7.98	8
9.95	10	8.20	8, 8.5
10.15	10	8.40	8.5
10.36	10, 10.5	8.61	8.5
10.57	10.5	8.82	8.5, 9
10.77	10.5, 11	9.02	9
10.98	11	9.23	9, 9.5
11.18	11	9.48	9.5
11.39	11, 11.5	9.64	9.5, 10
11.60	11.5	9.85	10

NOTE: ALL LENGTHS ARE IN INCHES.